How Lock Picking Works

by Tom Harris and Marshall Brain

Most people carry five to 10 keys with them whenever they go out. On your key ring you might have several keys for the house, one or two more for the car and a few for the office or a friend's house. Your key ring is a clear demonstration of just how ubiquitous lock technology is: You probably interact with locks dozens of times every week.



Keys are one of the most basic and essential machines we use every day.

The main reason we use locks everywhere is that they provide us with a sense of security. But in movies and on television, spies, detectives and burglars can open a lock very easily, sometimes using only a couple of paper clips. This is a sobering thought, to say the least: Is it really possible for someone to open a lock so easily?

In this edition of **HowStuffWorks**, we'll look at the very real practice of **lock picking**, exploring the fascinating technology of locks and keys in the process.

Under Lock and Key

Locksmiths define lock-picking as the manipulation of a lock's components to open a lock without a key. To understand lock-picking, then, you first have to know how locks and keys work.

Locks come in all shapes and sizes, with many innovative design variations. You can get a clear idea of the process of lock picking by examining one simple, representative lock. Most locks are based on fairly similar concepts.



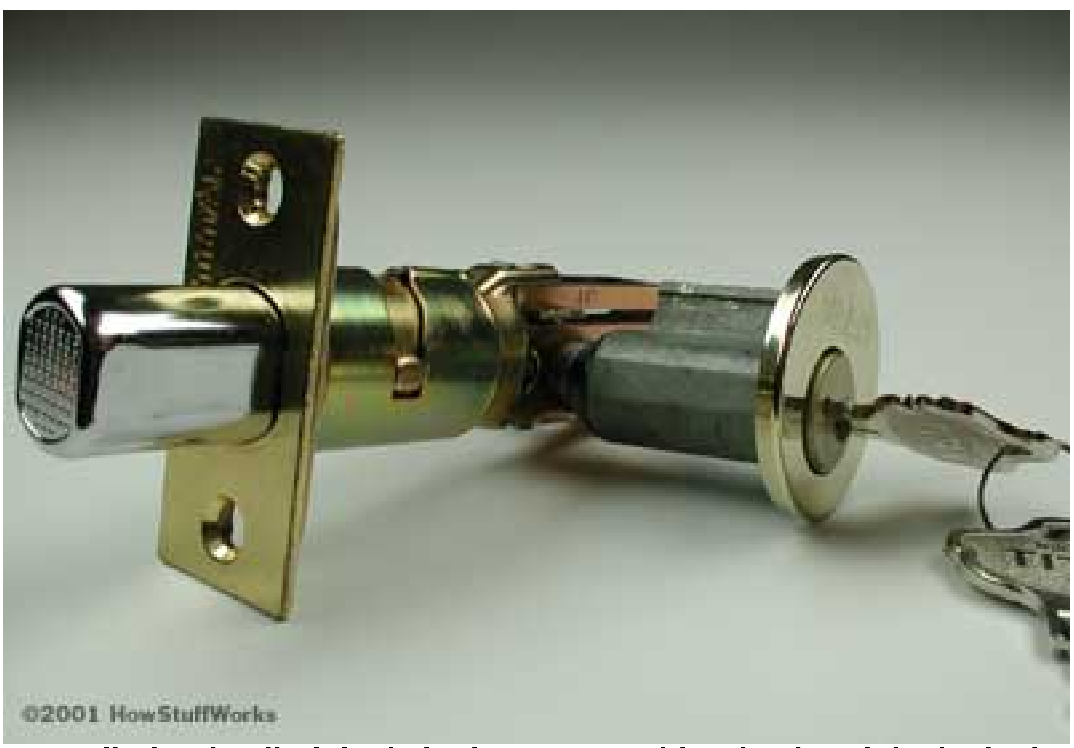
A standard deadbolt lock. When you turn the key, the bolt slides into a notch on the door frame.

Think about the normal dead-bolt lock you might find on a front door. In this sort of lock, a

movable bolt or latch is embedded in the door so it can be extended out the side. This bolt is lined up with a notch in the frame. When you turn the lock, the bolt extends into the notch in the frame, so the door can't move. When you retract the bolt, the door moves freely.

The lock's only job is to make it simple for someone with a key to move the bolt but difficult for someone without a key to move it. In the next section, we'll see how this works in a basic **cylinder lock**.





A cylinder deadbolt lock, in the open position (top) and the locked

position (bottom)

The Pin is Mightier than the Sword

The most common lock design is the **cylinder lock**. In the cylinder lock, the key turns a cylinder, or **plug**, which turns an attached cam (see illustration below). When the plug is turned one way, the cam pulls in on the bolt and the door can open. When the plug turns the other way, the cam releases the bolt and the spring snaps it into place so the door cannot open. In a deadbolt lock, there is no spring mechanism -- the turning cylinder slides the bolt forward and backward. A deadbolt is more secure than a spring-driven latch since it's much harder to push the bolt in from the side of the door.

Inside a cylinder lock, there is a sort of puzzle, which only the correct key can solve. The main variation in lock designs is the nature of this puzzle. One of the most common puzzles -- and one of the easiest to pick -- is the **pin-and-tumbler design**.

The main components in the pin-and-tumbler design are a series of **small pins** of varying length. The pins are divided up into pairs. Each pair rests in a shaft running through the central cylinder plug and into the housing around the plug. Springs at the top of the shafts keep the pin pairs in position in the plug. When no key is inserted, the bottom pin in each pair is completely inside the plug, while the upper pin is halfway in the plug and halfway in the housing. The position of these upper pins keep the plug from turning -- the pins bind the plug to the housing.

Click on the buttons to see what happens when you insert the wrong key in a lock (top) as compared to the correct key (bottom).

When you insert a key, the series of notches in the key push the pin pairs up to different levels. The incorrect key will push the pins so that most of the top pins are still partly in the plug and partly in the housing. The correct key will push each pin pair up just enough so that the point where the two pins come together lines up perfectly with the space where the cylinder and the housing come together (this point is called the **shear line**). To put it another way, the key will push the pins up so that all of the upper pins are inserted completely in the housing, while all of the lower pins rest completely in the plug. Without any pins binding it to the housing, the plug moves freely, and you can push the bolt in and out.





The pins in a pin-and-tumbler lock when no key is inserted (top) and

when the correct key is inserted (bottom). When the correct key is inserted, all of the pins are pushed up to the same level, flush with the shear line.

This simple puzzle design is very effective. Since the pins are hidden inside the lock, it's fairly difficult for most people to move the plug without the correct key. But, with a lot of practice, it is possible to solve the puzzle by other means. In the next section, we'll see how a locksmith goes about picking this sort of lock.

The Weakest Link

In the last section, we saw that the correct key will position the pins in a pin-and-tumbler lock so that all of the lower pins rest in the cylinder plug and all of the upper pins rest in the cylinder housing. To pick this sort of lock, you simply move each pin pair into the correct position, one by one.

There are two main elements involved in the picking process:

- **Picks** - Picks are long, thin pieces of metal that curve up at the end (like a dentist's pick). They are used to reach into the lock and push the pins up
- **Tension wrench** - Tension wrenches come in all shapes and sizes. Functionally, they aren't very complex. The simplest sort of tension wrench is a thin flathead screwdriver.

The first step in picking a lock is to insert the tension wrench into the keyhole and turn it in the same direction that you would turn the key. This turns the plug so that it is slightly offset from the housing around it. As you can see in the diagram below, this creates a slight ledge in the pin shafts.

While applying pressure on the plug, you insert a pick into the keyhole and begin lifting the pins. The object is to lift each pin pair up to the level at which the top pin moves completely into the housing, as if pushed by the correct key. When you do this while applying pressure with the tension wrench, you feel or hear a slight click when the pin falls into position. This is the sound of the upper pin falling into place on the ledge in the shaft. The ledge keeps the upper pin wedged in the housing, so it won't fall back down into the plug. In this way, you move each pin pair into the correct position until all of the upper pins are pushed completely into the housing and all of the lower pins rest inside the plug. At this point, the plug rotates freely and you can open the lock.

Another technique is **raking**. Raking is much less precise than actually picking. To rake a lock, you insert a pick with a wider tip all the way to the back of the plug. Then you pull the rake out quickly so that it bounces all of the pins up on its way out. As the rake exits, you turn the plug with the tension wrench. As they're moving up and down, some of the upper pins will happen to fall on the ledge created by the turning plug. Often, locksmiths will start by raking the pins, and then pick any remaining pins individually.

Conceptually, the lock-picking process is quite simple, but it is a very difficult skill to master. Locksmiths have to learn exactly the right pressure to apply and what sounds to listen for. They also must hone their sense of touch to the point where they can feel the slight forces of the moving pins and plug. Additionally, they must learn to visualize all the pieces inside the lock. Successful lock-picking depends on complete familiarity with the lock's design.

Lock Varieties

In the last section, we looked at pin-and-tumbler cylinder locks. You'll find this sort of lock

everywhere, from houses to padlocks. They are so popular because they are relatively inexpensive but offer fair security. For a typical pin-and-tumbler lock with five pins, there are about a million different pin configurations. When you consider the number of lock companies and lock designs, the chances of a criminal having the same key as you is fairly remote.



A pin-and-tumbler cylinder lock

Another common type of cylinder lock is the **wafer-tumbler lock**. These work the same basic way as pin-and-tumblers, but they have thin wafer-shaped tumblers rather than pins. You pick the wafers exactly the same way you pick pins -- in fact, it is a little bit easier to pick wafer-tumbler locks because the keyhole is wider.

Some designs use single wafers rather than wafer pairs. These wafers are spring loaded so that they extend out of the cylinder, binding with the lock housing. The wafers have a hole in the center that the key will fit through. The correct key pulls the wafers down just enough so that they are all retracted into the plug. The incorrect key will either pull the wafers down only part of the way or will pull them down too far, causing them to extend out the other side of the plug.



A wafer-tumbler cylinder lock

Double-wafer locks have wafer tumblers on both ends of the plug. To pick these locks, you work the wafers on both sides as you apply pressure with the tension wrench. Wafer locks are found in most filing cabinets, lockers and cars, as well as in many padlock designs.

Tubular locks offer superior protection to pin-tumbler locks and wafer-tumbler locks, but they are also more expensive. Instead of one row of pins, tubular locks have pins positioned all the way around the circumference of the cylinder plug. This makes them much harder to pick. Conventional lock-picking techniques usually don't work on this type of lock.

Some pin-tumbler locks have modified pins that make picking more difficult. In the most common variation, the upper pins have a mushroom-shaped head. This odd shape causes the plug to shift early, before you have actually pushed the top pin all the way up. This makes it more difficult to put the pins in position. It also makes it very hard to get an accurate feel for what's going on inside the lock.

Tools of the Trade

Experienced lock-pickers can make do with a few paper clips and a basic screwdriver, but the job is a lot easier when they have the proper tools. A basic lock-picking kit contains a tension wrench and several different picks. The picks differ mainly in the shape of their heads. Different heads are suited for particular sorts of locks and particular picking techniques.

Some lock-pickers will also use an electric **pick gun**. A pick gun basically consists of one or more vibrating, pick-shaped pieces of metal. You insert these long pieces of metal into the lock, just as you would insert a pick. As the metal pieces vibrate, they push the pins up. This works something like raking a lock. You turn the gun as the picks vibrate, so you catch some of the pins at the shear line. Sometimes these devices will open the lock in a matter of seconds, and sometimes they won't work at all. Most recreational lock-pickers avoid these devices because they take the puzzle-solving element out of the process.

Re-Keying a Lock

One cool thing about pin-and-tumbler locks is that you can re-configure them to fit an existing key (provided that the key is for the same lock design). The advantages of this are obvious: You can add new locks to your home or business without attaching a bunch of new keys to your key ring.

To make a new key for an existing lock, you cut a series of notches in the key so that it raises each of the upper pins just above the shear line. Essentially, you cut a pattern in the metal that matches the pattern of the pins in the lock. To change a lock so that it fits an existing key, you simply work in the opposite direction: You change the pattern of the pins in the lock so that it matches the pattern of notches in the key. If the lock is designed with a **universal keying system**, any locksmith can re-key the lock in no time. You can also get locks re-keyed at most hardware stores.



The shafts of a pin-and-tumbler lock contain several springs and tiny pins.

In this basic six-pin lock set, you can see how this re-keying works. When you open up the shafts in the cylinder and empty them out, you have six springs and 12 tiny pins. All of the upper pins are exactly the same size. The remaining six pins (the lower pins) will be of various lengths to match up with the notches on the key.



The right combination of pins lines up perfectly with the notches in the key.

The process of re-keying a lock is very simple. The locksmith removes all of the pins from the cylinder. Then, drawing from a collection of replacement pins of various sizes, the locksmith selects new lower pins that fit perfectly between the notches of the key and the shear line. This way, when you insert the new key, the lower pins will push all the upper pins just above the shear line, allowing the cylinder to turn freely. (This process may vary depending on the

particular design of the lock).

It doesn't matter how long the upper pins are (since they all rest above the shear line when the key is inserted), so the locksmith simply re-inserts the six original upper pins that came with the lock. And that's all there is to re-keying. The entire process takes only a few minutes.

Master Keys

Some locks are designed to work with two different keys. The **change key** will open only that specific lock, while the **master key** will open that lock and several others in a group. In these locks, a few of the pin pairs are separated by a third pin called a **master wafer** or **spacer**.

When three pins are combined in a shaft, there are two ways to position the pins so they open the lock. The change key might raise the pins so that the shear line is just above the top of the master wafer, while the master key would raise the pins so the shear line is at the bottom of the master wafer. In both cases, there is a gap at the shear line and the key is able to turn.

In this lock design, the lowest pin would be the same length in each lock in the group, but the master wafer would vary in length. This lets one person, say a building manager, access many different locks, while each individual key-holder can open only his or her own lock.

The Picker Code

Lock picking is an essential skill for locksmiths because it lets them get past a lock without destroying it. When you lock yourself out of your house or lose your key, a locksmith can let you back in very easily.

Lock-picking skills are not particularly common among burglars, mainly because there are so many other, simpler ways of breaking into a house (throwing a brick through a back window, for example). For the most part, only intruders who need to cover their tracks, such as spies and detectives, will bother to pick a lock.

Somewhere between the locksmith and the burglar is the recreational lock-picker, sometimes called a **hacker**. Like expert computer hackers, their code is to pick locks for the fun of it. Of course, breaking into any private property, no matter the intent, is illegal and unethical. If a person picks a lock that belongs to someone else, chances are the person will be arrested and face serious breaking-and-entering charges.

Simply understanding the principles of lock-picking may change your whole attitude toward locks and keys. Lock picking clearly demonstrates that normal locks are not infallible devices. They provide a level of security that can be breached with minimal effort. Most locks serve only to keep honest people honest and to discourage criminals. With the right tools, a determined intruder can break into almost anything.

Inside a Combination Lock

by Marshall Brain

You see combination locks every day, but have you ever stopped to think what is inside? In this edition of **How Stuff Works** we'll unlock the secrets of a combination lock! Here is the lock we will be exploring:





Getting inside a lock is not always easy. If it were easy, it would defeat the purpose of using the lock in the first place! But once you do get inside you find a collection of parts like this:



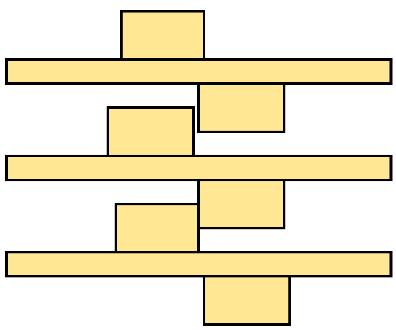
There are three cams in a typical combination lock. In this lock one of the cams is metal and is bonded directly to the turning face of the lock. The other two cams are plastic. There are two plastic spacers that fit between the cams:



They fit on a shaft molded into the back of the lock with a spring pressing the stack of cams together when the lock is assembled. The spring provides friction between the cams to hold them in place.



The cams each have one tooth on each side, and these teeth engage as the cams rotate:



The purpose of the cams is to control a latch that engages the end of the lock's hasp. The cams each have an indentation in them. When the indentations align properly the latch is able to fit into the indentations and release the hasp:



Otherwise the latch engages the hasp like this:



If you have used a combination lock before you know the drill: "Turn the dial clockwise two full rotations to the first number of the combination. Then turn it counter-clockwise past the first number to the second number. Then turn the dial clockwise to the third number and the lock will open." You can now see why you have to do that. Turning the dial 2 full revolutions gets the teeth of all three cams engaged, so the three cams are turning in unison. Now when you turn counter-clockwise only the top cam is rotating. As you go past the first number, the first cam's tooth engages the second cam, so now the two cams are moving. The friction provided by the spring, however, keeps the third cam in its position. When you turn the dial clockwise again, only the top cam rotates. Once all three indentations are aligned properly by this process, the lock opens.

You could, in theory, stack up 4 (or 10) cams if you wanted to. It would make for a tedious session opening the lock, but it would certainly be secure!

How Power Door Locks Work

by Karim Nice

Between the keypads, keyless entry systems and conventional locks, some cars today have four or five different ways to unlock the doors. How do cars keep track of all those different methods, and what exactly happens when the doors unlock?



The mechanism that unlocks your car doors is actually quite interesting. It has to be very reliable because it is going to unlock your doors tens of thousands of times over the life of your car.

In this edition of **HowStuffWorks**, we'll learn just what's inside your door that makes it unlock. We'll take apart the **actuator** that does the work, and then we'll learn how the lock can be forced open. But first, let's see how the car keeps all its signals straight.

Locking and Unlocking

Here are some of the ways that you can unlock car doors:

- With a key
- By pressing the unlock button inside the car
- By using the combination lock on the outside of the door
- By pulling up the knob on the inside of the door
- With a keyless-entry remote control
- By a signal from a control center

In some cars that have power door locks, the lock/unlock switch actually sends power to the actuators that unlock the door. But in more complicated systems that have several ways to lock and unlock the doors, the body controller decides when to do the unlocking.



The **body controller** is a computer in your car. It takes care of a lot of the little things that make your car friendlier -- for instance, it makes sure the interior lights stay on until you start the car, and it beeps at you if you leave your headlights on or leave the keys in the ignition.

In the case of power door locks, the body controller monitors all of the possible sources of an "unlock" or "lock" signal. It monitors a door-mounted touchpad and unlocks the doors when the correct code is entered. It monitors a radio frequency and unlocks the doors when it receives the correct digital code from the radio transmitter in your key fob, and also monitors the switches inside the car. When it receives a signal from any of these sources, it provides power to the actuator that unlocks or locks the doors.

Now, let's take a look inside an actual car door and see how everything is hooked up.

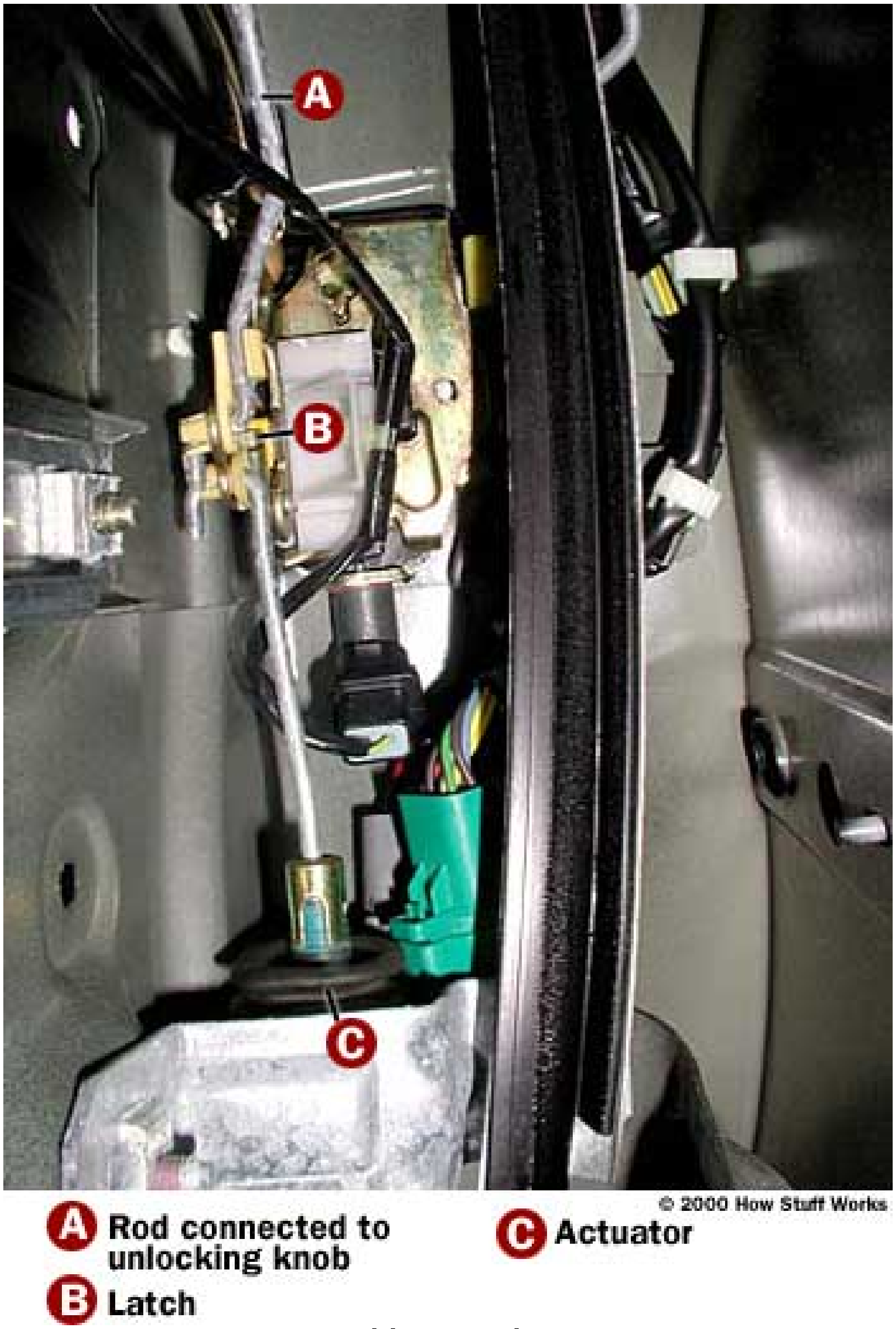
Inside a Car Door

In this car, the power-door-lock **actuator** is positioned below the latch. A rod connects the actuator to the latch, and another rod connects the latch to the knob that sticks up out of the top of the door.



A car door

When the actuator moves the latch up, it connects the outside door handle to the opening mechanism. When the latch is down, the outside door handle is disconnected from the mechanism so that it cannot be opened.



Inside a car door

To unlock the door, the body controller supplies power to the door-lock actuator for a timed interval. Let's take a look inside the actuator.

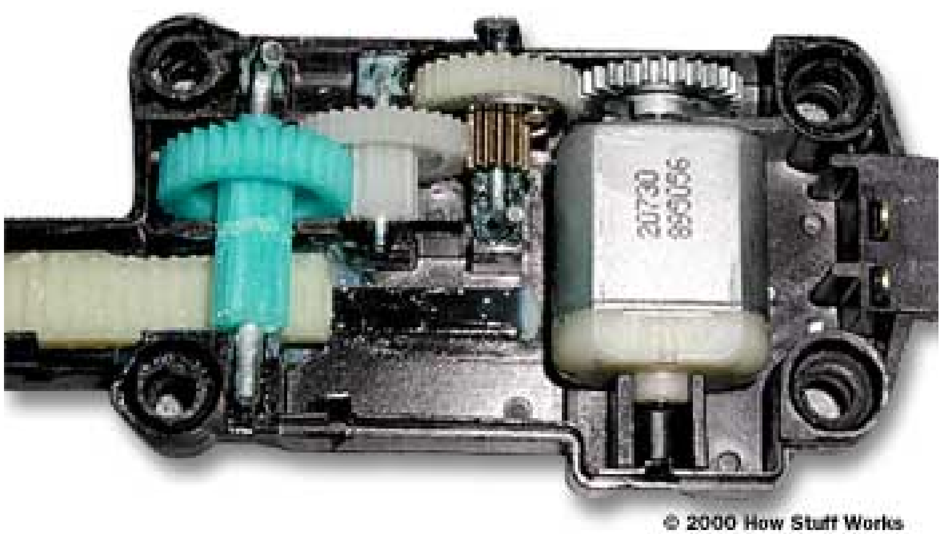
Inside the Actuator

The power-door-lock actuator is a pretty straightforward device.



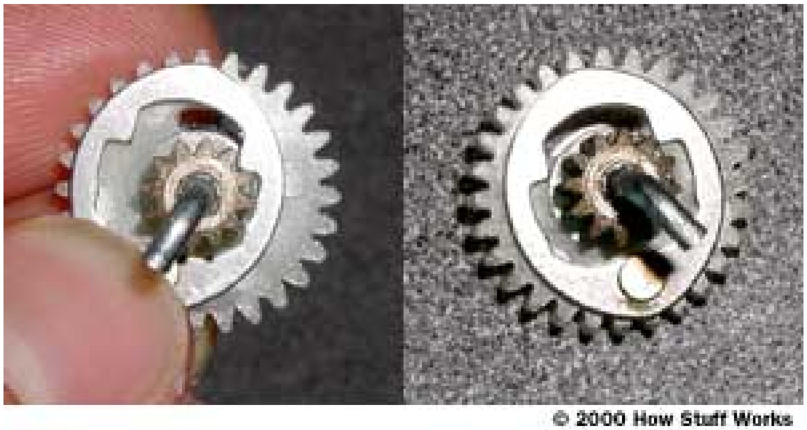
This actuator can move the metal hook shown in this photo to the left or right. When mounted in the car, it is vertical, so the hook can move up or down. It mimics your motions when you pull the knob up or push it down.

This system is quite simple. A small electric motor turns a series of spur gears that serve as a gear reduction. The last gear drives a rack-and-pinion gearset that is connected to the actuator rod. The rack converts the **rotational motion** of the motor into the **linear motion** needed to move the lock.



Inside the power-door-lock actuator

One interesting thing about this mechanism is that while the motor can turn the gears and move the latch, if you move the latch it will not turn the motor. This is accomplished by a neat centrifugal clutch that is connected to the gear and engaged by the motor.



Centrifugal clutch on the drive gear

When the motor **spins** the gear, the clutch swings out and **locks** the small metal gear to the larger plastic gear, allowing the motor to drive the door latch. If you move the door latch yourself, all of the gears will turn except for the plastic gear with the clutch on it.

Forcing the Lock

If you have ever locked yourself out of your car and called the police or AAA to help you get back in, you know that the tool used is a thin metal strip with a flat **hook** on it. From this article you can now see how this strip works.

A simple **vertical motion** from either the knob on the door or the power-lock actuator is all that's needed to turn the lock and open the door. What the officer is doing with the metal strip is fishing around until he or she hooks onto the point that the knob and actuator connect to. A quick pull on this point and the door is unlocked!

For more information on power door locks and related topics, see the links on the next page.

How Anti-shoplifting Devices Work

Let's imagine for the moment that you own a large department store, and you are having a big problem with shoplifting. (You're not alone -- retail stores lost $26 billion last year to shoplifting!) What are you going to do? You cannot let it continue, because every month your accounting system tells you that you are losing thousands of dollars to theft. It forces you to raise your prices, and that means you have to charge more than the store next door. That can make it very hard to compete, especially if the store next door is successfully discouraging shoplifting.

As a retailer focusing on the problem of what's known in the industry as **loss prevention**, you basically have three methods at your disposal to slow the shoplifters down: (1) You can watch everyone in the store like a hawk and make sure they don't steal anything. You can do that using security guards and/or video survelliance systems; (2) You can make things hard to remove from the store by bolting them down, attaching cables, putting things in display cases and behind the counter; (3) You can use a system that attaches special **tags** onto everything so that an alarm goes off whenever a shoplifter tries to walk out with an item. In this edition of **How Stuff Works**, we'll look at each of these options in more detail.

How Does Video Surveillance Work?

Our first option involves the use of deterrents such as security guards, observation mirrors (that allow store clerks to see throughout the store) and **closed-circuit television (CCTV)** surveillance systems. Most large stores use some combination of these techniques, which were among the earliest tools used to combat shoplifting. Smaller businesses, unable to afford security guards, were able to install videocameras -- usually in a prominent place so that shoppers knew they were being watched -- to record activity in the store. Later, the retailer could review the tapes on a VCR, observe shoppers behaving suspiciously (sometimes even stealing) and note the vulnerable displays or areas in the store. The problem with this record-and-review system is that some shoplifters get away with stealing. On the other hand, experts say, the system has merit in that it allows for possible recognition of repeat offenders (something that is prevalent among shoplifters). By reviewing these tapes, the store owner can also learn about theft patterns and get ideas about ways to deal with them.

Your imaginary department store would probably use electronic surveillance a bit differently than smaller businesses. You might have security staff monitoring store activity on closed-circuit TV as it happens in an effort to prevent shoplifting. Today, there are even systems that allow retailers with several locations to monitor stores and distribution centers from a single location. These remote surveillance systems allow users to send full-frame video image streams over high-speed phone lines to other locations and to electronically store digital video images for review or evidence.

And in larger stores, cameras are often less visible. Next time you're in your favorite department store, look around. High-speed, high-resolution digital cameras may be mounted in smoke detectors, sprinkler heads, thermostats or clocks. (It's popular to mount cameras in **ceiling tile domes** (they're bubble-like and tinted so no one can see where the camera is

pointed). From this vantage point, a **pan/tilt/zoom** camera can swing about and follow someone around the store. (If security is not monitoring and operating the camera, it can be set up to pan automatically but will not follow someone around the store.)

Video cameras used for security purposes don't look anything like the video camera your family has at home -- they're becoming smaller and more specialized. A standard surveillance camera might be in the neighborhood of 4 inches long by 2 1/2 inches wide with a lens on the end, according to Jeff Bates of ADT Security Systems in Raleigh, N.C. A hidden camera might be a **board camera**, which basically is a 1 inch by 1 inch square computer board with a tiny lens, perhaps 1/4 inch in size. These cameras are designed to two specifications, experts say: they must be small and easy to hide.

Is Anchoring the Merchandise in Place a Good Idea?

Now for option number two: locking things up nice and tight. **Cable, wire products and security bars**, like those manufactured by Se-Kure Controls (Canada) Inc., are also familiar types of retail security devices. They certainly work to keep your merchandise in the store! But retail industry experts say this isn't the best way to move your products because cables and other locking devices make it difficult for people to examine items and try on garments. Customers have to get a clerk to come release the item so they can try it on or look at it. Since most people are in a hurry, this might motivate shoppers to move on to a store where the merchandise is more accessible.

Having said that, if you need to use security cables and locking racks, there's a wide variety of products available to you. Security cables are made with a variety of properties: coaxial cables (for CCTV systems), alarm cables and fiberoptic cables. **Wire lanyards**, which can be snaked through a garment to attach it to a rack or display, are being made stronger all the time. For example, Retail Security Products offers to send potential customers a lanyard test kit to illustrate the strength -- over 250 pounds in a pull test -- of their product. You've probably also seen the locked steel racks used for expensive coats and jackets -- again, these have to be unlocked by a sales clerk.

How Do Tag and Alarm Systems Work?

Security experts say the most effective anti-shoplifting tools these days are CCTV and the tag-and-alarm systems, better known as **electronic article surveillance (EAS)** systems. Separately, these are good options. Used together, experts say, they're almost unbeatable. EAS is a technology used to identify articles as they pass through a gated area in a store. This identification is used to alert someone that unauthorized removal of items is being attempted. According to the Association of Automated Identification Manufacturers, over 800,000 EAS systems have been installed worldwide, primarily in the retail arena. EAS systems are useful anywhere there is an opportunity for theft of items of any size. Using an EAS system enables the retailer to display popular items on the floor, where they can be seen, rather than putting them in locked cases or behind the counter.

Loss prevention expert Robert L. DiLonardo, says new EAS technologies are being produced --

not only to reduce shoplifting -- but also to help increase sales, lower labor costs, speed inventory, improve stockroom logistics and, one day, to replace inventory record-keeping. But for now, we'll stick to the role of EAS in battling shoplifting in your imaginary store!

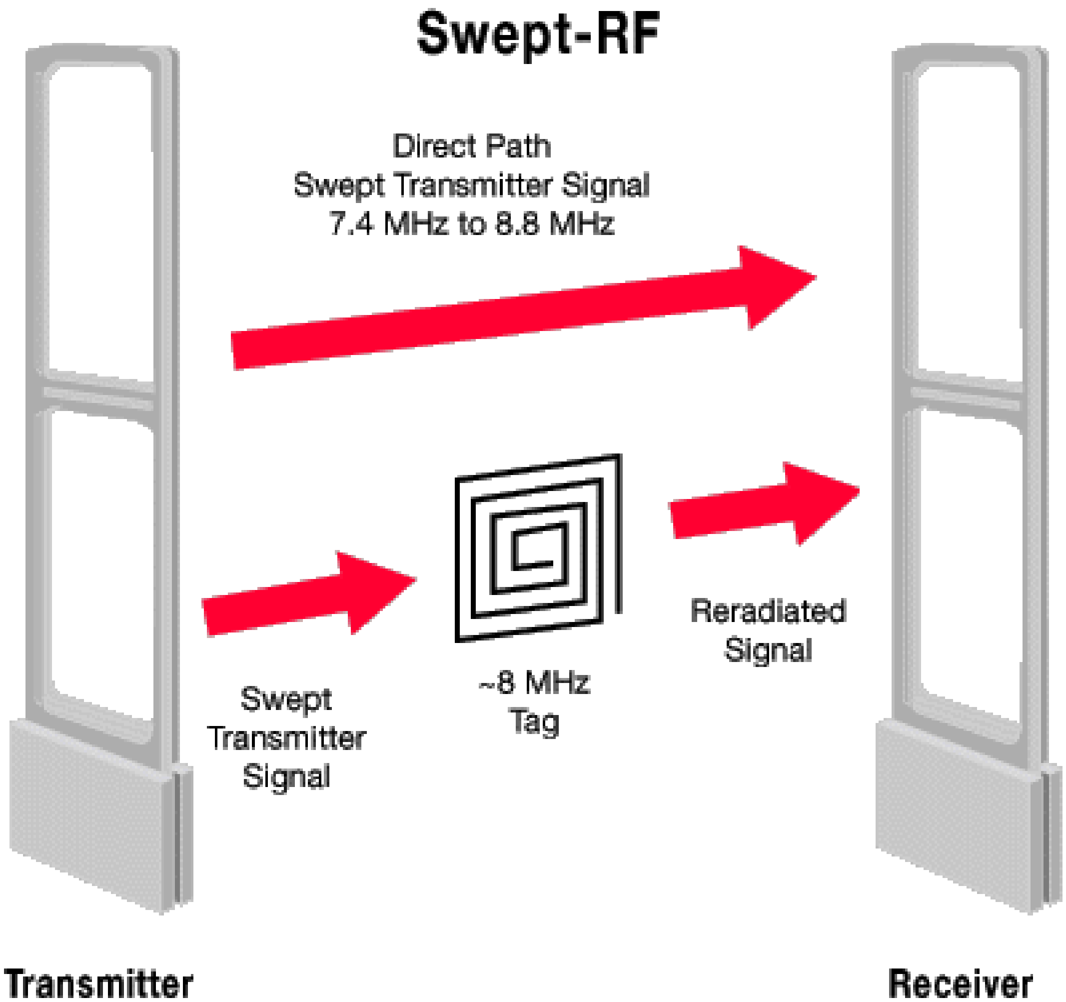
Three types of EAS systems dominate the retail industry. In each case, an EAS tag or label is attached to an item. The tag is then **deactivated**, or taken from an active state where it will alarm an EAS system to an inactive state where it will not flag the alarm. If the tag is a hard, reusable tag, a detacher is used to remove it when a customer purchases the item it's attached to. If it's a disposable, paper tag, it can be deactivated by swiping it over a pad or with a handheld scanner that "tells" the tag it's been authorized to leave the store. If the item has not been deactivated or detached by the clerk, when it is carried through the gates, an alarm will sound.

The use of EAS systems does not completely eliminate shoplifting. However, experts say, theft can be reduced by 60 percent or more when a reliable system is used. Even when a shoplifter manages to leave the store with a tagged item, the tag still must be removed -- something that is no longer as easy as it once was. For example, some EAS tags contain special ink capsules, which will damage the stolen item when forcibly, and illegally, removed. (This type of device is known in the industry as **benefit denial** -- we'll discuss it more later!). Other popular EAS components today include **source tagging**, whereby an inexpensive label is integrated into the product or its packaging by the manufacturer.

The type of EAS system dictates how wide the exit/entrance aisle may be, and the physics of a particular EAS tag and technology determines which frequency range is used to create a surveillance area. EAS systems range from very low frequencies through the radio frequency range (see How Radio Scanners Work). These EAS systems operate on different principles, are not compatible and have specific benefits and disadvantages. (That's why the Consumer Products Manufacturers Association, Inc. is encouraging a "tower-centric" EAS approach that can "read" multiple tag technologies rather than the "tag-centric" models that exist today.)

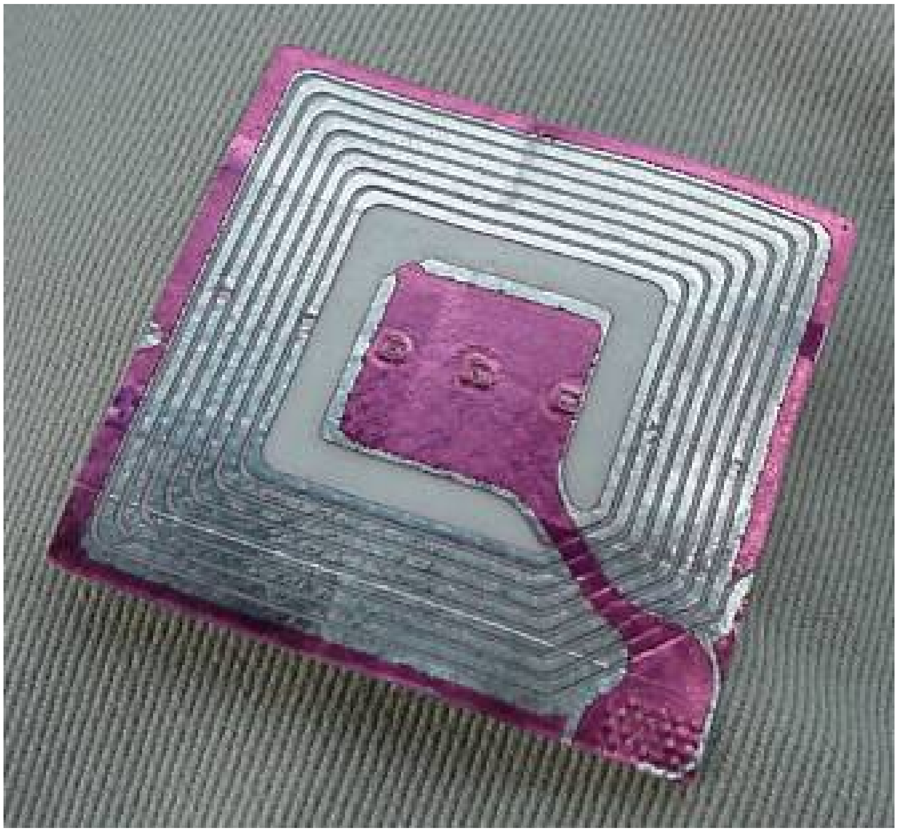
How Do Radio Frequency EAS Systems Work?

Radio Frequency (RF) Systems are the most widely used systems in the United States today and RF tags and labels are getting smaller all the time. As you can see in the drawing at the right, the RF EAS system works like this: A label -- basically a miniature, disposable **electronic circuit** and **antenna** -- attached to a product responds to a specific frequency emitted by a transmitter antenna (usually one pedestal of the entry/exit gate). The response from the label is then picked up by an adjacent receiver antenna (the other pedestal). This processes the label response signal and will trigger an alarm when it matches specific criteria. The distance between the two gates, or pedestals, can be up to 80 inches wide. Operating frequencies for RF systems generally range from 2 to 10 MHz (millions of cycles per second); this has become standard in many countries. Most of the time, RF systems use a **frequency sweep** technique in order to deal with different label frequencies.



Sometimes both the transmitter and receiver are combined in one antenna frame -- these are called **mono systems** and they can apply pulse or continuous sweep techniques or a combination of both. According to Tag Point Ltd. experts, mono systems could be effective for you if your store's entry is small. The mono system is used with hard labels, which are slightly more expensive than paper labels used with RF sweep techniques.

Sensors (gates/pedestals) made by Checkpoint Systems, one of the largest manufacturers of EAS products, emit a low-energy RF pulse, which "listens" for the tag. This technology, known as **digital signal processing**, actually "learns" about its surroundings so that it can accurately distinguish between the tag signal and extraneous noise. Store employees love this because it virtually eliminates false alarms! (Store owners often ask why there are no invisible sensors. Cross Point experts say it is technically possible to create an invisible system by, for example, installing an antenna loop around a store's door. However, tests have shown that the preventive value of a visible system is greater and results in decreased theft.)

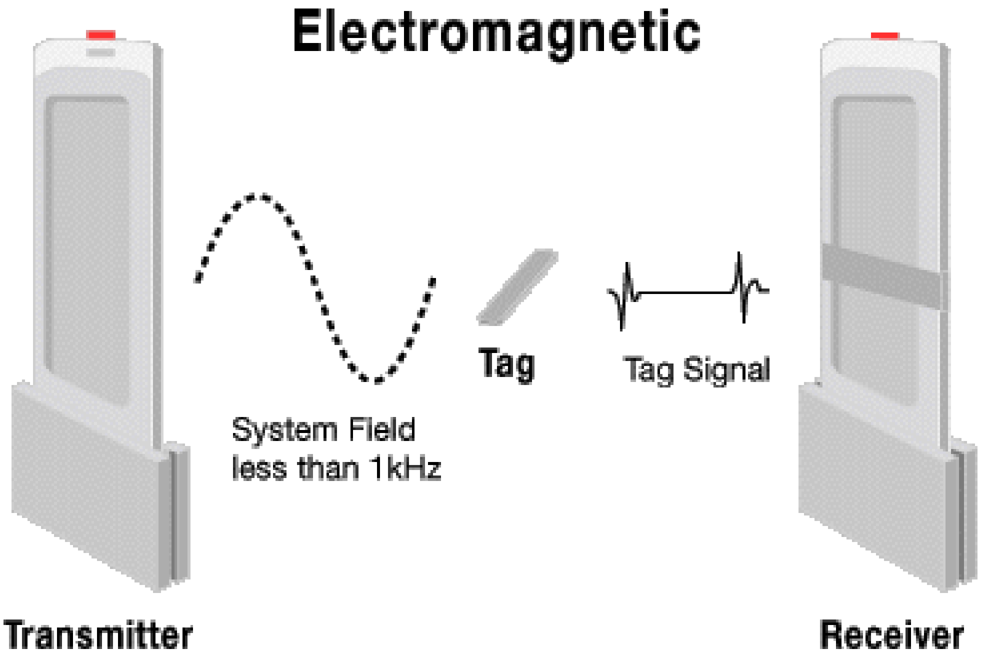


This tag is about 1.5 inches (3 cm) square. On the other side is an innocuous paper label that says, "Thank you for shopping with us!"

There are many different ways to implement an RF system (see this patent and the patents it references for one type of implementation). The basic idea is that the tag has a helical antenna etched from thin aluminum bonded to a piece of paper. At the end of the antenna is a small diode or RC network that causes the tag to emit a radio signal in response to the radio signal it receives. To disarm the tag, a strong RF pulse (much stronger than the gates emit) blasts the tag and burns out the diode or RC components. Between the gates a burned out tag does not emit a signal, so the gates let it pass without an alarm.

How Does An Electromagnetic System Work?

The **Electromagnetic (EM) system**, which is dominant in Europe, is used by many retail chain stores, supermarkets and libraries around the world. In this technology, a magnetic, iron-containing strip with an adhesive layer is attached to the merchandise. This strip is not removed at checkout -- it's simply deactivated by a scanner that uses a specific highly intense magnetic field. (One of the advantages of the EM strip is that it can be re-activated and used at a low cost.)



What most people refer to as an electromagnetic tag is actually a metal wire or ribbon that has high **permeability**, making it easy for magnetic signals to flow through it, according to Sensormatic's EAS Product Co. CTO Hap Patterson. "When we drive the tag, flux is being allowed to flow through the tag until it's saturated," he says. "When it's saturated, from a magnetic perspective, it begins to look like air. Saturation occurs abruptly and is an important part of the design of the tag."

Look at the figure showing the EM system with its receive coil and transmitter on either side and tag in the middle. When the tag goes from active to saturated, the receiver detects the change in the amount of the signal picked up from the transmitter. "If you look at the receiver signal, you'll see a bump when saturation occurs," Patterson says. Saturation occurs twice each cycle-once on the transmitter's positive cycle and once on its negative cycle. What is happening is the system is checking for the special material used to make the tag. (In scientific terms, the permeability of steel is much lower than the metal used to make the tag. In addition, when steel goes to saturation, it tends to do so slowly, not abruptly. So the EM system uses these differences to differentiate between a still-active tagged item leaving the store and a wrench in someone's pocket.)

A magnetized piece of semi-hard magnetic material (basically, a weak magnet) is put up next to the active material to deactivate it. When you magnetize the semi-hard material, it saturates the tag and puts it in its inactive saturated state.

That same kind of tag is often used in the library, where it can be reactivated by demagnetizing the semi-hard magnetic material.

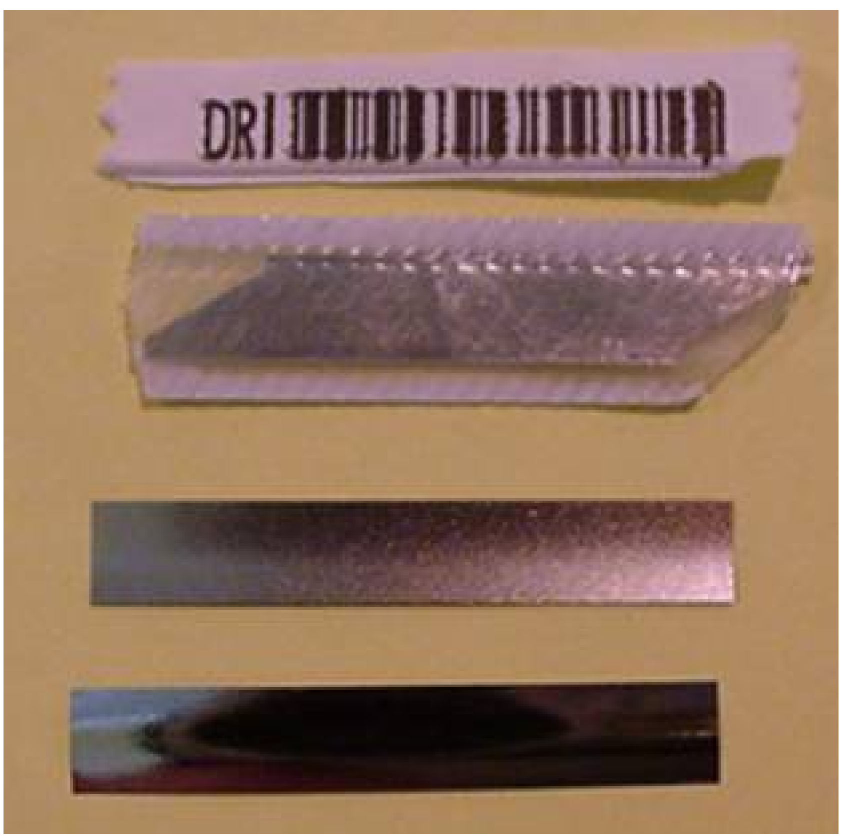
The EM system works by applying intensive low frequency magnetic fields generated by the transmitter antenna. When the strip passes through the gate, it will transmit a unique frequency pattern. This pattern is, in turn, being picked up by an adjacent receiver antenna. The small signal is processed and will trigger the alarm when the specific pattern is recognized. Because of the weak response of the strip and the low frequency (typically between 70 Hz and 1 kHz) and

intensive field required by the EM system, EM antennas are larger than those used by most other EAS systems, and the maximum distance between entry pedestals is 40 inches. Also, because of the low frequency here, the strips can be directly attached to metal surfaces. That's why EM systems are popular with hardware, book and record stores. (Check out the patent for more details!)

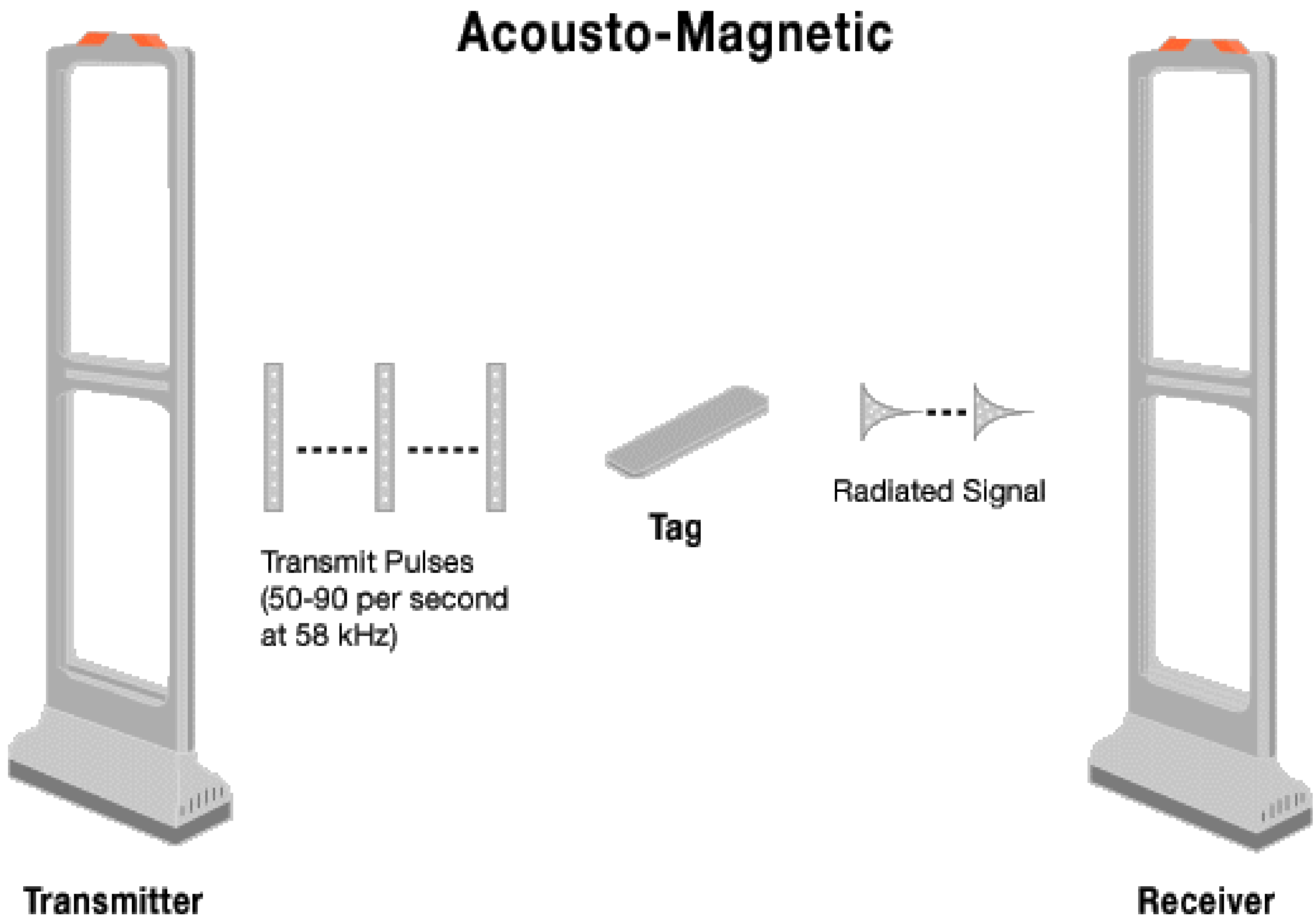
What's the Third Type of EAS System Used Most Often?

The newer **acousto-magnetic system**, which has the ability to protect wide exits and allows for high-speed label application, uses a transmitter to create a surveillance area where tags and labels are detected. The transmitter sends a radio frequency signal (of about 58 kHz) in pulses, which energize a tag in the surveillance zone. When the pulse ends, the tag responds, emitting a single frequency signal like a tuning fork. While the transmitter is off between pulses, the tag signal is detected by a receiver. A microcomputer checks the tag signal detected by the receiver to ensure it is at the right frequency, is time-synchronized to the transmitter, at the proper level and at the correct repetition rate. If all these criteria are met, the alarm occurs.





A typical AM tag from Wal-Mart



AM material is highly **magnetostrictive**, which means that when you put the tag material in a magnetic field, it physically shrinks. The higher the magnetic field strength the smaller the metal becomes. The metal actually shrinks about one-thousandth of an inch over its full 1.50 inch length.

As a result of driving the tag with a magnetic field, the tag is physically getting smaller and larger. So if it is driven at a mechanically resonant frequency, it works like a tuning fork, absorbing energy and beginning to ring.

This tag also requires **bias magnet** material in addition to active element material. The active material will shrink no matter which direction the magnetic field is placed upon it. If the tag is driven with Frequency, F, it gets smaller as the magnetic field increases and larger as it's driven towards zero. This means that while it is being driven at F, the tag is trying to work at 2F, because at both positive and negative halves of the drive signal, the tag is getting smaller. To get the tag to work at F, a bias field is required. The bias is provided by a semi-hard magnetic element in the label. When magnetized, the bias prevents the active element from ever being in a zero field condition. So for an entire half of the drive signal, the tag shrinks. Then it expands for the other half. This results in an F response.

When you walk through the gate with a tag, the transmitter in the gate energizes the material

and causes it to resonate at F. The transmitter then stops. The tag will continue to "ring" at F for a short period of time, and the receiver listens for that frequency. If it hears it, it knows there is a tag and sounds the alarm.

When the AM tag is demagnetized, it is deactivated. When it's magnetized, it is activated. (This is the opposite of how the deactivation of EM tags works.)

(Home Depot began using acousto-magnetic tags from Sensormatic Electronics Corp. because the tags work well when they're close to metal and the stores use metal shopping carts -- not all systems work well with metal objects.) For more detail on this system, check the patent!

Other EAS technologies include the **microwave system**, one of the oldest anti-shoplifting systems and judged by experts to be only about 80 percent accurate, is still around in some stores. Security experts also caution retailers that this system is not compatible with increasingly popular source tagging options. (We'll discuss source tagging more later!)

What Other Devices and Components Are Used with the EAS Systems?

In addition to the all-important gates or pedestals you walk through, the most important components of EAS systems include the following:

- **Disposable tags** -- Disposable paper tags and labels are available in many different types -- pressure-sensitive labels with simulated bar codes, tags or labels that can be imprinted with price, inventory, promotional or bar-code information, and tags specially designed for products such as earrings, compact discs and cosmetics, which are all items easily pocketed by shoplifters. These thin, adhesive-backed labels can be as small as a paper clip and can be easily disguised to look like standard retail tags. Most importantly, the radio frequency tags, unlike tags connected to some electromagnetic sensors, can't be disrupted by common magnets.



Paper tags like these are disposable and widely used with radio frequency systems.

- **Reusable tags** -- Probably the most familiar reusable tag is the hard, plastic tag (known as an alligator) attached to most apparel and armed with an almost impossible to defeat locking mechanism -- it can also be a pain if it's attached to the wrong part of a garment you want to try on! This off-white, pin-connected tag requires a special detacher unit to remove it. (If you've ever had a clerk accidentally leave one of these on your purchase -- sometimes a tag buried in a bag-full of stuff can go through the sensor without detection, store clerks say -- you know that you cannot get that thing off at home! Some

department stores offer a terrific, public relations service: if their clerk fails to remove this tag from your purchase, the store will send someone to your home with a removal device. This means you can wear that new dress to the event you bought it for!) Other reusable tags you might have seen include plastic devices without pins (they use a foam rubber pad! and abrasive strip to grip garment firmly without causing damage), lightweight colored tags encased in clear plastic, flexible tags printed with a simulated bar code, and fluid tags.



You'll find these reusable tags on most apparel.

- **Benefit denial tags** -- This is a fluid tag. If you steal an item with this kind of tag, you're going to get an unpleasant surprise when you try to remove it in the dressing room or later at home. The ingenious tags have been designed to break and release fluid -- usually colored indelible inks -- onto the garment (working even against gravity) and on you if you try to forcibly remove it. The idea is that a shoplifter is being denied any benefit from his/her crime and will not be able to use or sell the item because it has now been ruined.

- **Deactivators and detachers** -- Desirable qualities in deactivators include a large deactivation zone and 100 percent deactivation with no false alarms. The type of electronic deactivator depends upon the kind of EAS system and tags used by the store. We're all familiar with hand-held **scanners** and flat scanner pads used to swipe and deactivate merchandise tags. Traditionally, scanners must touch a label directly to use specific frequency to deactivate it. But with the growing use of source tagging (hiding identification tags somewhere on an item or in its packaging) **proximity deactivators**, or verifiers that don't require contact with a label, are becoming more important. There are also mass or bulk deactivators, which bring EAS labels from an inactive state to an active state while the products are still packaged in master cartons or cases. A plus of state-of-the-art deactivation devices is that they can be integrated into all of the commercially available bar code scanners. (See How UPC Bar Codes Work) so that clerks are scanning the product code at the same time they're deactivating the security circuit. (See this patent for more information on how a deactivator works.) To remove most hard tags, a **detacher/releaser** is necessary. Today's detachers, which basically unlock the tags, are designed so that they cannot be copied or purchased by shoplifters. Some detachers are hand-held; others are fixed -- most are simple devices with no moving parts, something that makes them very durable.



Store clerks use electronic scanners to deactivate tags on your purchase.

- **Radio frequency identification (RFID)** -- RFID is used in a variety of ways today, including automating toll collection and decreasing time at the gas pump. RF technology experts say RFID is the way of the future in the retail security arena as soon as the application software is in place. Checkpoint Systems has collaborated with Mitsubishi Materials Corp. to develop **RF intelligent tagging**, which combines an integrated circuit

with an RF antenna to deliver a tag capable of simultaneously storing and processing information about a product while protecting the product from theft. (It can even identify a shoplifter who comes back in wearing a stolen item, since only the security portion of the tag is turned off when an item is purchased. The RFID tag is always on!) Researchers say this technology could someday mean that we don't have to unload our grocery carts for checkout -- the system could gather the information it needs from each item while it remains in the! shopping cart!

- **Accessories and other products** -- In addition to selling hundreds of different types of labels, label applicators, security pins, locking devices for ink tags and security lanyards for use with EAS systems, some companies even offer "dummy" or inactive EAS tags and systems. Retail Security Products claims these tags and labels can be used as stand-alone deterrents to theft, with inactive EAS pedestals or in conjunction with a live EAS system on lower priced items. (They sold over 20 million of the dummy tags -- at 1/3 cents each -- to retailers across the United States last year, they say.) Other manufacturers and experts warn that dummy labels, if used, should be easily distinguishable only to shop personnel.

What Is Source Tagging All About?

As its name implies, source tagging is the embedding of disposable RF security labels at either the point of manufacture or packaging. Source tagging has been highly successful in the packaged products industry, and retailers, such as discount giant Target, are starting to use it for merchandise such as earrings, apparel, shoes, batteries, videocassettes, audiotapes, computer software, sporting goods and electronics. (Retailers' interest in source tagging has increased as shoplifters have gotten around anti-shoplifting tags applied to the outside of packages by removing the product and leaving the empty box on the shelf!)

The newest source tags are paper-thin and easily integrated into automated production processes. These tags are applied in primary packaging (or within or on the product itself -- for example, incorporated into woven garment tags) and under labels on bottles. Checkpoint experts say their two-dimensional source tags can be invisibly embedded between layers of thin paper stock or cardboard on standard blister packages. These invisible tags, which are deactivated by the clerk with a verifier that needs no physical contact with the tag to work, are especially effective at addressing employee theft and represent a hot topic in retail security today.

Sensormatic Products says its tiny Ultra-Strip can be detected through foil, liquids or layers of packaging. (Some industry consultants question the future of source tagging in retail apparel in light of the large number of existing microwave EAS systems -- systems that some consider obsolete and that cannot be adapted to incorporate low-cost source tagging in the future. There are also questions about how best to incorporate source tagging without losing the tag's inherent value as a theft deterrent.)

How Much Does An EAS System Cost? And I've Heard They Can Be Dangerous for People

Wearing Internal Medical Devices -- Is That True?

Experts say there are large differences in cost depending on the system, the size of the store and the amount of merchandise to be protected. By using state-of-the-art equipment such as digital signal processing and customized locks that can't be released by common detachers, theft can be reduced by about 60 percent. Considering that store personnel will have more time for assisting shoppers (instead of watching for potential thieves), a reliable EAS system can pay for itself in 1 1/2 to 2 years.

You may have heard news accounts a couple of years ago of research that claimed entry/exit sensors could be harmful to people wearing internal medical devices such as pacemakers and defibrillators. The U.S. Food and Drug Administration acknowledges that internal medical devices might be slightly affected by some EAS systems. However, officials there don't consider this a public health problem. Many Americans were alarmed when the Heart Institute of St. Petersburg, Fla., released results of a two-year study of EAS systems and their possible effects on people wearing pacemakers and defibrillators. Researchers said they found that the electromagnetic fields of anti-shoplifting systems can interfere with cardiac devices if users linger in the magnetic zone between the pedestals or gates. Soon after, the FDA announced that, of the 1 million Americans with internal medical devices such as pacemakers, there had been only 44 reported reactions over the past 10 years related to anti-theft system magnetic fields. Heart Institute researchers encourage people with internal medical devices to avoid any potential problems by moving quickly through these systems as well as metal detectors.

Now that you know more about the kinds of anti-shoplifting devices being used in stores, take a look at this article on reducing shrinkage (an industry term for lost merchandise) by Roger Schmedlen for some additional ideas about security in your imaginary -- or real -- department store.

And if you're someone who needs help conquering a pattern of shoplifting, please contact Shoplifters Anonymous. They can help!

How Burglar Alarms Work

by Tom Harris

Burglar alarms have become standard equipment in stores and other businesses, and they're becoming increasingly common in private homes as well. If you've ever shopped for a home security system, then you know there are a wide variety of options available. These systems range from do-it-yourself kits you can pick up for $10 to sophisticated whole-house security networks that must be installed by professionals. But, as it turns out, most alarm systems are actually built around the same basic design concepts.

In this edition of **How Stuff Works**, we'll take a look at these concepts and examine a few specific alarm designs. As you'll see, some of the most effective alarm systems are also the simplest.

Breaking the Circuit

Other than the family dog, the most basic burglar alarm is a simple **electric circuit** built into an entry way. In any circuit, whether it's powering a flashlight or a computer, electricity only flows when you give it a path between two points of opposite charge. To turn the electricity on or off, you open or close part of the circuit.

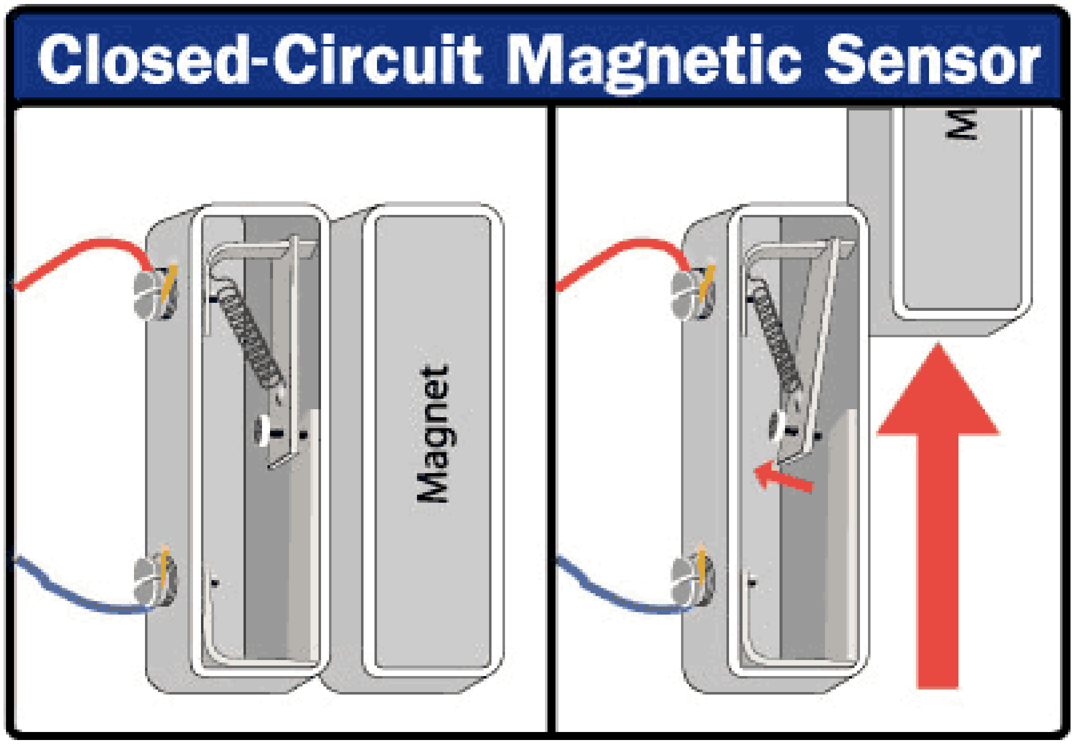
To open or close a **flashlight circuit**, you simply throw a **switch**. In a burglar alarm, the switch detects the act of intrusion -- opening a door or window, for example. These sorts of alarms are divided into two categories:

- In a **closed-circuit system**, the electric circuit is **closed** when the door is shut. This means that as long as the door is closed, electricity can flow from one end of the circuit to the other. But if somebody opens the door, the circuit is opened, and electricity can't flow. This triggers an alarm.
- In an **open-circuit system**, opening the door closes the circuit, so electricity begins to flow. In this system, the alarm is triggered when the circuit is completed.

There are a number of ways to build this sort of circuit into an entry way. Closed circuits are normally a better choice than open circuits because an intruder can deactivate the open circuit by simply cutting the connected wires.

A magnetic sensor in a closed circuit consists of a few simple components. For the most basic design, you need:

- a battery powering a circuit
- a spring-driven metal switch built into a door frame
- a magnet embedded in the door, lined up with the switch
- a separately-powered buzzer with a relay-driven switch.



When the door is closed, the magnet pulls the metal switch closed so the circuit is complete. The current powers the relay's electromagnet, so the buzzer circuit stays open. When you move the magnet by opening the door, the spring snaps the switch back into the open position. This cuts off the current and closes the relay, sounding the alarm.

You can also build this sort of system into a window. If an intruder pushes a window open, the magnet slides out of line with the switch, and the buzzer is activated.

Another simple burglar alarm uses a **small button** as the switch. The button is embedded in the door frame, so closing the door pushes it in. When somebody opens the door, the button is released, changing the circuit and sounding the alarm.

With just a battery and buzzer, these designs make for fairly flawed security systems. After all, the burglar only needs to close the door again to turn the buzzer off. That's why most modern burglar alarms incorporate another piece into the circuit -- the **control box**.

The control box is hooked up to one or more alarm circuits, but it also has its own power supply. It monitors the circuits and sounds the alarm when they are closed or opened (depending on the design). But once the alarm is triggered, the control box won't cut it off until somebody enters a security code at a connected **keypad**. For added security, the control box is usually positioned in an out-of-the-way spot, so the intruder can't find it and attempt to destroy it.

Using this basic concept, you can create all sorts of alarm systems. Just imagine what a burglar might do to break into a house, and then turn that action into the circuit switch. For example, an intruder might break through a window, so you could make the glass itself a circuit. The easiest way to do this is run a current through a thin line of **foil wire** affixed to the surface of the glass. If a burglar breaks the glass, the circuit is broken, and the alarm is triggered.

Floor mats are another simple option. A basic floor mat uses an open circuit design with two metal strips spaced apart. When somebody steps on the mat, the pressure pushes the two metal strips together, completing a circuit.

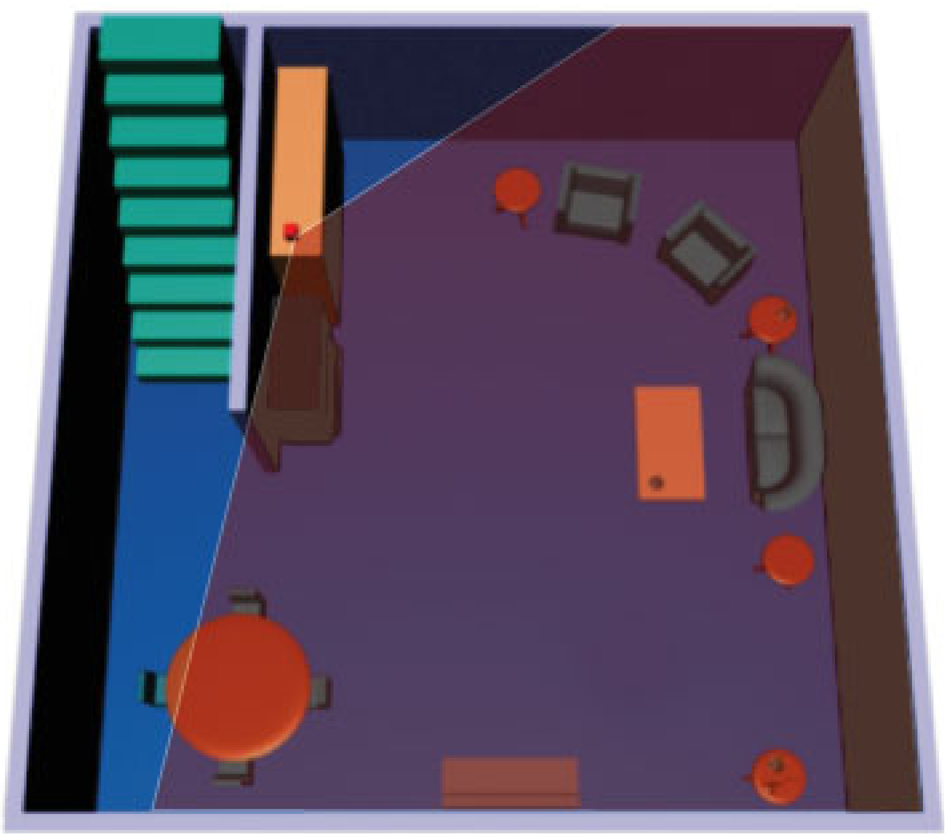
All of these circuit systems are best for guarding the **perimeter** of a house or business -- the points an intruder would enter the building. In the next section, we'll look at systems that detect an intruder once he or she has already made it inside.

Detecting Motion

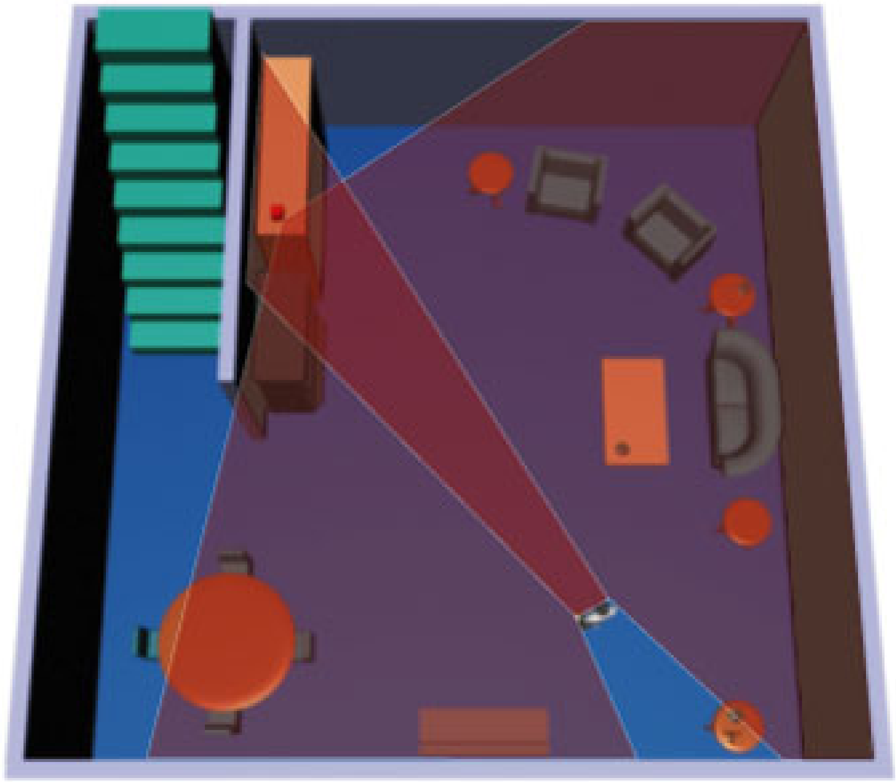
Circuit alarms are very effective for guarding the perimeter of a house, but they don't work so well inside a building. This is because the intruder's actions are highly unpredictable -- you don't know where they'll go or what they'll touch. A specific "trigger" isn't very effective. To detect an intruder who's already in the house, you need a **motion detector**.

Basic motion detectors are fairly common these days. You see them all the time in automatic doors, for example. There are several different sorts of detectors.

An automatic door opener is an example of a **radar-based motion detector**. The box above the door sends out bursts of microwave radio energy (or ultrasonic sound waves), and then waits for the reflected energy to bounce back. If there is nobody in front of the door, the radio energy will bounce back in the same pattern. But if somebody enters the area, the reflection pattern is disturbed. When this happens, the sensor sends a signal and the door opens. In a security system, the sensor sends an alarm signal when the reflection pattern in a room is disturbed.



The motion detector emits radio energy into a room and monitors the reflection pattern.



If somebody disturbs the reflection pattern, the motion detector sends an alarm signal to the control box.

Another simple design is a **photo-sensor** motion detector. These are the devices you might see in a store at a shopping mall. When somebody enters the store, the motion detector sounds a chime or bell. Photo-sensors have two components:

- a source of **focused light** (often a laser beam)
- a light sensor

In a home security system, you aim the beam at the light sensor, across a passageway in your house. When somebody walks between the light source and the sensor, the path of the beam is blocked briefly. The sensor registers a drop in light levels and sends a signal to the control box.

More advanced security systems include **passive infrared** (PIR) motion detectors. These sensors "see" the infrared energy emitted by an intruder's body heat. When an intruder walks into the field of view of the detector, the sensor detects a sharp increase in infrared energy. Of course, there will always be gradual fluctuation of heat energy in an area, so PIR detectors are designed to trigger the alarm only when infrared energy levels change very rapidly. See this page for details.

All these motion detector designs can be combined in a house to offer complete coverage. In a typical security system, the control box will not sound the alarm immediately when the motion

detectors are triggered. There is a short delay to give the homeowner time to enter a security code that turns the system off.

If the security code is not entered, however, the control box will activate various alarms. In the next section, we'll look at some of the alarm types you might find in a typical security system.

Sounding the Alarm

There are several things a security system might do when it detects an intruder. In an advanced system, the control box will be wired to several different components. Typically, it will activate:

- a siren or other loud alarm noise
- flashing outdoor lights
- a telephone auto-dialer

The siren and lights serve three functions:

- They alert occupants and neighbors that someone has broken into the house.
- They drive the intruder away.
- They signal to police which house has been broken into.

The telephone auto-dialer can:

- Dial the police directly, and play a pre-recorded message giving the address of the house and any other relevant information. This message will usually play over and over so that the police will still hear it even if the call is put on hold for some time.
- Dial the security company that installed the equipment. In this case, the control box can feed specific information about the intrusion -- which circuits or motion detectors were activated, etc. The security company then relays this information to the police.

Home security is a rapidly growing field, and there are new and improved burglar alarms popping up all the time. For the most part, these systems are all built around the same basic structure. A central control box monitors several motion detectors and perimeter guards and sounds an alarm when any of them are triggered.

To find out about specific alarm devices and new installation techniques, check out the sites listed in the Links section, or talk to a security system installer in your area.

search

Advanced Search | Safe Search

Error 404 - File Not Found

Sorry, the page cannot be found

The web page you're seeking was not found because it may no longer exist, it may have been moved or renamed, or there may be a typo in the referring page.

You may find what you're looking for by using the searchbox at the top of this page or by clicking on one of the links below.

Topics on Lycos

- **Autos**
  Buy, Sell, Research...
- **News**
  Headlines, Technology...
- **Real Estate**
  Find a home, Get Financing...
- **Shopping**
  Lycos Shop, Auctions...
- **Small Business**
  Tools, Research, Start a Biz...
- **Sports**
  Fantasy, NBA, Baseball...

NARROW YOUR SEARCH: Physicians Desk Reference . Drug Reference . Html Reference . Reference Manager . Letter Of Reference . Javascript Reference

Help

WEB RESULTS: Showing Results **1 thru 10** of 20,526,152 (info)

1. refdesk.com
   refdesk.com This Web site was developed for "indexing quality Internet sites and assisting visitors in navigating these sites.... Refdesk.com has three goals: (1) fast access, (2) intuitive and ...
   www.refdesk.com June 9, 2004 - 31 KB

2. **reference**.com

   www.reference.com August 6, 2004 - 38 KB

3. Open Directory - **Reference**
   about dmoz | report abuse/spam | help the entire directory only in **Reference** Top: ReferenceDescription See also: This category in other languages: Afrikaans (52) Arabic (119) Armenian (12) Asturian...
   dmoz.org/Reference July 22, 2004 - 13 KB

4. [Yahoo! Directory **Reference**]
Reference Directory > **Reference** Advanced Search | Suggest a Site email this category to a friend INSIDE YAHOO! CATEGORIES Top Categories Additional Categories SPONSOR RESULTS (Whats this?) (Become a...
www.yahoo.com/Reference June 9, 2004 - 20 KB

5. [WebReference.com - The Webmaster's **Reference** Library - Web Authoring...]
Writing A DTD for An XML File Do you know how to write the grammar for an XML data file? Learn how to specify the structure of the data in the DTD. - Similar Tips internet.com Developer Downloads...
www.webreference.com August 6, 2004 - 41 KB

6. [google web directory]

directory.google.com/Top/Reference August 5, 2004 - 36 KB

7. [**Reference**: Dictionary, Encyclopedia, Thesauri, Usage, Quotations, and...]
Bartleby.com combines the best of both contemporary and classic **reference** works into the most comprehensive public **reference** library ever published on the web.
www.bartleby.com/reference June 28, 2004 - 28 KB

8. [JavaScript Central]
Skip to: [content] [navigation] Search JavaScript Central This is the place for documentation and references about the JavaScript programming language.
developer.netscape.com/docs/manuals/communicator/jsre... July 1, 2004 - 12 KB

9. [Internet Public Library]
Arts & Humanities Business Computers Education Entertainment Health Government Regional Science & Tech Almanacs Calendars Dictionaries Books Magazines Search
www.ipl.org/ref July 12, 2004 - 8 KB

10. [xrefer]
library services publisher services news about Would you like access to xreferplus? Find out if your library already subscribes. Thomson Gale and xrefer form strategic partnership. Read about this...
www.xrefer.com July 22, 2004 - 9 KB

« Previous **11 thru 20** **21 thru 30** **31 thru 40** **41 thru 50** **Next** »

reference | Web | Search | ☐ Search within these results

☒ **ADULT FILTER** ◉ Strict- Filter explicit content EDIT

NARROW YOUR SEARCH: Physicians Desk Reference . Drug Reference . Html Reference . Reference Manager . Letter Of Reference . Javascript Reference

NEED A SECOND OPINION? HotBot, Web Directory

refdesk.com
The Single Best Source For Facts

Check E-mail: Select one:
QuickLinks: Select one:
NetTools: Select one:

Make Refdesk Your Home Page | FAQs
About Refdesk | Site Map | Contact
Best viewed at 1024 X 768 screen resolution
Visits since August 1, 2004:
4207951

"Our Future Depends On Your Support"
Click to Support Refdesk
'04 Donations To Date = 48% of Goal - Details
"Information is the currency of democracy. " - Jefferson

Since 1995, free and family friendly. Refdesk indexes and reviews quality, credible, and current information-based sites and assists readers in navigating these sites. Introduction and Tour.

Search Resources

Search Google: Help - News - Tips

Go

Search Yahoo!: Local - News - Tips

Go

Search MSN: News - Tips

Go

Search Refdesk: Help

Go

Search OneLook Dictionary

Enter word or phrase:

Free Refdesk Daily Mailings: Subscribe Here

Bonus Site: Free Upgrade: Windows XP Service Pack 2

The best way to get a free upgrade for Windows XP is by using the Automatic Updates feature in Windows. Visit the 'Protect Your PC' site to let Microsoft turn it on for you or follow three manual steps - either way you will get Service Pack 2 automatically as Microsoft releases it.

Site of the Day: Internet Archive

The Internet Archive, a comprehensive library of Internet sites and other cultural artifacts in digital form. Includes the "Wayback Machine," a free service allowing people to access and use archived versions of past web pages. Members of the public can search and view the Internet Archive's enormous collection of web sites,

Sun, Aug 8, 2004 - 12:27pm

Atomic Clock | Time Zone | World Clock
Calendar: '03 | '04 | '05 | '06

Current Gas Prices:
AAA | GasBuddy | The Oil Crunch

In the News:

- Iraqi Gov't Gives Amnesty for Minor Crimes
- U.S.: al-Qaida Suspect Cased New York
- S.F. Man Says Beheading Video Is a Hoax

Go

Search M-W Dictionary: Help

Go

Search M-W Thesaurus: Help

Go

Sponsored By:

Word Search: Help

Select Choice:

Go

People Search: Help

First Name Last Name

City or Zip State

All States

Search WhitePages.com

- Business Search
- International Directories
- Reverse Address Look Up
- Reverse Phone Look Up

Site Information:

dating back to 1996 and comprising over 10 billion web pages.

- SOTD Archive
- Pop-up/Spam/Spyware Resources

Thought of the Day: Tell a friend about Refdesk.com

"Doubt is to certainty as neurosis is to psychosis. The neurotic is in doubt and has fears about persons and things; the psychotic has convictions and makes claims about them. In short, the neurotic has problems, the psychotic has solutions." - Thomas Szasz | TOTD Archive

Word of the Day: effface

from Dictionary.com

More: OED | MW | NYT | WS

Word Game of the Day

Word of the Week

- Daily Buzzword | Word Game
- Analogy of the Day
- Daily Word Quiz
- GRE QOTD
- SAT QOTD | SAT NYT
- Spelling Bees: One | Two

Current Events Topic:

"Four of the five states with the largest percentage increases in housing units between April 1, 2000, and July 1, 2003, are in the West, the U.S. Census Bureau reported. Nevada led all states with a 13 percent increase in the number of homes over the 39-month period. It was followed by Arizona, Colorado and Georgia (all about 9 percent) and Utah (8 percent). Nevada has had the highest annual rate of

- Judge to Mull England Defense Witnesses
- Vending Machines Making Room for Health
- More: Google - MSNBC - Topix - Yahoo

Today in History:

- AP - Encarta - HC - LOC - NYT

Sponsored By:

Support Refdesk By Visiting Sponsors Thank You!

Local News: (Enter ZIP Code)

Go

TOPIX.NET

Search News: (e.g., Terror)

GO

- USA/World Newspapers
- Top 10 U.S. Newspapers
- Today's Papers: Summary
- Today's Front Pages
- Political Cartoons

- About Refdesk
- Advertising Policy
- Ask Bob
- Contact Refdesk
- Disclaimer
- Make Refdesk Your Home Page
- Privacy Policy
- Site Map | FAQs
- Testimonials | Awards
- Advertise on Refdesk

Quick Find:

- America's Job Bank
- Ancestors
- Birthdays
- Citizen Gateway Gov't Srvs
- E-mail Addresses
- Economy at a Glance
- Elected Officials
- Federal Toll-Free Numbers
- Health Information
- Internal Revenue Service
- Legal Information
- Lowest Prescription Cost
- Maps/Driving Directions: 1 - 2 - 3
- Medicare.gov
- Nat. Do Not Call Registry
- Obituaries
- Request Military Records
- Our Documents
- Social Security Online
- Think Tanks
- U.S. Gov't Blue Pages
- U.S. Representatives

population growth for 17 consecutive years. Texas added about half a million new homes to its housing inventory between 2000 and 2003 to lead the nation in numerical growth. These gains boosted Texas•ousing inventory to 8.7 million in 2003. Florida was a close second, adding 485,000 housing units over the period. California (up 442,000), Georgia (295,000) and North Carolina (257,000) rounded out the top five in this category." - Source

Daily Diversions:

A Game A Day - Arts & Letters Daily - Book Review - Comics - Crosswords - Current Sky Information - Daily Almanac - Daily Download - Daily Humor - Events, Births, History - Family Site of the Day - Headline of the Day - Horoscope - Human Nature Daily - Latest Gallup Polls - Late Night Jokes - Letterman Top Ten - Lottery Results - Moon Phases - Movies - Old Farmer's Almanac - Poetry Daily - Prayer of the Day - Quote of the Day - Science Daily - SciTech Daily Review - This Day In Jazz History - Today In Literature - Tonight's Sky - TV - Writer's Almanac - Yahoo What's New   Just For Fun >>

Today's Pictures:

Astronomy Picture of the Day - Earth's Current Temps/Clouds - Earth Images - Earth Observatory - Earth Science - Kodak - Latest Mars Images - Latest Saturn Images - Nat. Geographic - NOAA Image of the Day - Space Imaging Gallery - Top

- Industry Watch
- More Headlines
- News Photos

News Sources:

ABC-AP-BBC-Bloomberg CBC-CBS-CNN-Excite-FOX IHT-Google-MSNBC-MyWay-NPR NYT-Reuters-RocketNews-Topix Tucows-UPI-USA Today-WNN Wash. Post-Wash. Times-Yahoo

Features:

- Current Dow Jones Avg.
- Crude Oil/Energy Prices
- Commodities Futures
- Daily Fuel Gauge Report
- Market Charts-Overview
- Drudge Report
- Weather-Comics(1)
- Comics(2)-Sports
- Health-Tech-Science
- Business-Politics-Op/Ed
- Entertainment -Odd

News/Resources:

- 9/11 Commission Full Report

• U.S. Senators
• Vital Public Records
• White/Yellow Pages

News Photos - Wash. Post Day in Photos - Weather - More Weather Pics

Today's Potpourri:

• **Trivia of the Day:** Trivia Collection
• **Computer Virus Threats:** CNET - McAfee - Symantec - Trend Micro - VirusList - Yahoo
• **Health:** ABC - AP - BBC - CNN - Harvard - HealthScout - Reuters - SARS
• **Science:** ABC - AP - BBC - CNN - MSNBC - NASA - NewScientist.com - Reuters - Scientific American - Space.com
• **Technology:** AP - CNET - MacCentral - PC Magazine - PC World - Reuters - TechWeb - USA Today - Wash. Post - ZDNet
• **News Quiz:** Daily - Facts Behind the News
• **Misc:** Ask Yahoo Questions - Birthdays - Crossword - Daily Motivator - EPIC - Garden Tip - Good News - Google Answers - Harper's Index - Health Tip - Music History - Pun - SciTech Review - Search Engine News - Trivia - TV Nielsen Ratings - Internet Health Report - Internet Traffic Report - Free Online Security Scan

Reference Resources:

• America Responds
• CBS News Disaster Links
• DoD News Releases
• FBI News Releases
• Federal News Service
• UN News Service
• War in Iraq

Get Stock Quotes:

(Enter Stock Symbol)

Go

• Symbol Lookup

Weather Resources:

Current Weather:
(Enter City, State or Zip Code
or Airport Code or Country)

Go

• Lightning Explorer
• U.S. Radar Loop
• National Doppler Radar
• NOAA's Warnings
• Weather Alerts
• more >>

• Top 15 Refdesk Pages
• Essential Reference Tools
Basic Sources, 14 Topics

• Ask the Experts
• Beginner's Guides
• Editor's Picks
• Facts Encyclopedia
7,500+ Sites - 73 Topics
• Fast Facts
• First Things First
• Indispensable Sites
• Journalist's Tools
• Net Usage Snapshot
• Search Engines

• Facts Subject Index
2,000+ Sites - 24 Topics
• Homework Helper
• Quick Research
300+ Research Sites
• Ref. Shelves on the Net
• USA & World Newspapers
Op-Ed | Journalists

Refdesk Site Map

Facts-at-a-Glance

10-10 Phone Rates: Comps
2003 U.S. Statistics
2004 College Rankings
2003 Hospital Rankings
50States.com

A Bell Tolls:LD Rate Comps
Acronym Finder
Airborne Express
Airline Flight Tracker
Airline Toll-Free

Facts Search Desk

Content Resources:

Reuters/AP Headlines [ ] Go

Fact Monster [ ] Go

Computer Glossary [ ] Go

Medical Dictionary [ ] Go

Law Dictionary [ ] Go

Bartleby.com
Select Search
[ ]
Go

Translation Dictionaries (one word only, e.g. fact)

English to Spanish [ ] Go

English to German [ ] Go

Help and Advice

Browser Updates:
Internet Explorer
Mozilla
Netscape
Opera

Ask the Experts
Consumer Search
Do-it-Yourself.com
Do-it-Yourself Resources
Free Legal Advice
Homework Helper
How Stuff Works
How To Clean

Numbers
America's Job Bank
American Fact Finder
Annual Reports
Area Code Finder
Area Code Listing
AT&T Toll-Free
Bible, King James Version
Biography.com
Calculator : Day of the Week
Calculators
Calendar: Customized
Calendar: Perpetual
Canada Postal Lookup
Canadian Statistics
Chemical Elements.com
Chiefs of State
CIA World Fact Book 2003
Consumer Info
Consumer Price Index
Contacting Congress
Convert Anything

Dictionaries:

- American Heritage
- Biographical
- Computing
- Crossword
- Encarta World English
- Financial
- High-Tech
- Legal
- Medical
- Spanish-English

English to Italian [ ] Go

English to French [ ] Go

Translate Text / Website: AltaVista - Google - Yahoo

Search Engines: AllTheWeb - AltaVista - AskJeeves - Google - HotBot - ixquick - Kartoo - LookSmart - MetaCrawler - MSN - Netscape - Teoma - Vivisimo - Yahoo! - more >>

Current News / Weather / Business / Sports

• **Headlines:** 1st Headlines - AP Wire - Business - Entertainment - Health - Photos/AP - Reuters - Science - Sports - Technology - UPI Headlines - USA Today - Weather - Odd - more >>

• **Weather:** AccuWeather Service - CNN Weather - FEMA Storm Watch - Intellicast - National Hurricane Center - National Storm Warnings - Tropical Storms Worldwide - USA Today Weather - Weather Channel - Yahoo! Weather - more >>

• **News:** ABC - AP - BBC - Bloomberg - CBC - CBS - CNN - FOX - Google - MSNBC - MediaNews - NPR - PBS - Reuters - TV News Archive - UPI - more >>

• **Newspapers:** Atlanta Journal-Constitution - Arizona Republic - Baltimore Sun - Boston Globe - Christian Science Monitor - Chicago Sun-Times - Chicago Tribune - Cleveland Plain Dealer - Dallas Morning News - Denver Rocky Mountain News - Detroit Free Press - East Valley Tribune - Houston Chronicle - Los AngelesTimes - Miami Herald - Minneapolis Star Tribune - Newark Star-Ledger - New York Daily News - New York Post - New York Times - Newsday - Philadelphia Inquirer - Pittsburgh Post-Gazette - San Diego Union-

Anything
Information Please
Internet Public Library
Learn To Do Anything
Microsoft Knowledge Base
WannaLearn.com
The Why Files

Top Reference Tools

Almanacs
Refdesk's Daily Almanac
The Old Farmer's Almanac

Biographies
Columbia Encyclopedia
Biography.com

Calculators & Conversion
Calculators Online Center
Currency Converter
Unit Converter

Census & Demographics
American Factfinder
PopNet
Worldwide Census Info

Date and Time
Perpetual Calendar
Timeanddate.com

Dictionary & Thesaurus
Merriam-Webster Online
Thesaurus.com
YourDictionary

- Units
- Weather

Doctor Board Verification
Drug Information

Encyclopedias:

- Britannica Concise
- Canadian
- Columbia 2002
- Encarta
- Home Improvement
- Legal
- Medical
- Technology
- Weather

EURO Conversion Rates
Exchange Rates
FedEx

Find:

- Ancestors
- Birthdays
- College
- Doctor
- Elected Officials
- House
- Job
- Lawyer
- E-mail Addresses
- Government Stats
- Health Information
- Legal Information
- Lowest Prescription Cost
- Medical Information
- Military Information
- People
- U.S. Cities Guide

Tribune - San Francisco Chronicle - St. Louis Post-Dispatch - Seattle Times - USA Today - Washington Post - Washington Times - Archives - more >>

• **International News:** Afghanistan News - Al Jazeera - Ananova - Asahi Shimbun - Canada Online - China Daily - Ha'aretz Daily - Gazeta.ru - Globe and Mail - Guardian - Inter. Herald Tribune - Irish Times - Islamic Republic News Agency - Itar-Tass - Japan Times - Jerusalem Post - Korean News Service - Kyodo News - Le Monde - London Times - London Telegraph - Pakistan News Service - People's Daily - Pravda - Sydney Morn. Herald - Seoul Times - Sky News - South China Morn. Post - Taipei Times - WorldNews.com - World Press Review - Xinhua - more >>

• **Business News:** Barrons - Bloomberg - Business Daily Review - CBS MarketWatch - CNBC - CNN/Money - Financial Times - Economist - Forbes - Fortune - Investor's Bus. Daily - Kiplinger - Morningstar - Motley Fool - Red Herring - SmartMoney - TheStreet.com - WSJ - more >>

• **Sports:** CBS Sportsline - ESPN - GolfWeb - Inside Hoops - NASCAR.com - NBA.com - NFL.com - Sports HotSheet - Sports Illustrated - more>>

• **Magazines:** Atlantic - Bus. Week - CFOnet - Economist - Harper's - Nat. Review - Newsweek - New Yorker - People - Reader's Digest - Salon - Slate - Sci. Amer. - Time - TV Guide - US News - more >>

• **Columns/Commentary:** Dave Barry - David Broder - Dear Abby - William F. Buckley Jr. - Maureen Dowd - Matt Drudge - Ellen Goodman - Paul Harvey - Molly Ivins - Rush Limbaugh -

Encyclopedias
Britannica Concise
Columbia
Encarta

Genealogy/ Obituaries
Ellis Island Records
Cyndi's Genealogy Sites
Family Search
Genealogy Learning Center
Nat. Obituary Archive
Obits 101
Researching Your Roots

Geography & Maps
Aerial/Satellite Images
ImageAtlas
MapQuest
National Geographic
Perry-Castaneda Maps
Yahoo! Maps

Health
CancerNet
Mayo Clinic
MEDLINE Plus
Nat. Inst. of Health
WebMD

People Finder
Langenberg
WhitePages.com
World Telephone Directories

Quotations
Bartlett's
Quoteland.com

Style & Writing Guide

- U.S. Gov't Sites
- U.S. Representatives
- U.S. Senators
- Vital Records

Flags of the World
Foreign Words and Phrases

Grant Writing Guides
Gray's Anatomy
How Far Is It?
Kelley Blue Book
Language Translator
Legal Resources
List of Lists
Library of Congress
Maps: USA & World
Maps/Driving Directions: 1 - 2 - 3
Merck Manual Home Edition
Merck Manual of Geriatrics

Occupational Handbook
Physician's Desk Reference
Postage Rates Worldwide
Pop. Clocks: US/World
Public Records Database
Robert's Rules of Order
Rulers of the World
Soc. Security Death Index

George Will - WSJ - Yahoo Op/Ed - more >> #1 - #2

• **Net/Tech News:** c|net - CNN Technology - ClickZ - Net News - NewsLinx Web News - Slashdot - Wired - ZDNet - more >>

• **Miscellaneous:** Arts Journal - Editorials - First Chapter: NYT - WP - Movie Research - Movie Reviews - Opinion-Pages - Writ - more >>

Refdesk Subject Categories

Refdesk Site Map

Facts/Internet
Agents/Robots
Beginner's Guides
Cool Site of the Day
Computer Graphics
Computer Hardware
Computer Software
Devices/Gadgets
Download Page
Free Stuff
Fun Stuff
Libraries
Linux Resources
Magazines
Phone Book
Net Resources
Reference Shelves
Time and Date

Social Sciences
Business/Career
Crime/Law Enforce.
Education
Environment
Family Matters
Food/Recipes
Health
Homework Helper
Kids Stuff
Legal Resources
Personal Finances
Seniors Online
Sports
Women's Issues

Language
Dictionaries
Encyclopedias
Grammar/Style
Quotations

Natural

Applied Sciences
Automotive
Aviation
Career
Mental Health
Military
Pets/Animals

Art/Entertainment
Arts & Culture
Movies
Music
Photography

Literature
Books/Literature
Electronic Texts

Geography/History
Biography
Genealogy
Geography

APA Style
Citation Styles
Common Errors in English
Commonly Confused Words
Elements of Style
Grammar, Punctuation, and Spelling
Guide to Grammar/Writing

Just For Fun

2003: Year in Review
Top Web Sites: PC Magazine
Top 500 Search Keywords

A Game A Day
AirportMonitor: Real Time
Anagram Server
Analogy of the Day
Aphorisms Galore!
Classical Music Archives
Coffee Break Game Arcade
Cool Signatures
CopyKat Recipes
Crazy Fads
Crosswords
Daily Comics
Daily Fuel Gauge Report
Diary of Samuel Pepys
Download Sites

Strunk's Elements of Style
State & Local Gov't Sites
UPS
U.S. Census Bureau
U.S. Postal Service
Veterinary Manual
White Pages
Who's Alive/Who's Dead
World Atlas/Geo. Facts
World Time Server
World Time Zone Map
Yellow Pages
ZIP 4 Code Look-up
ZIP Codes: International
more >>

Weights/ Measures
Windows Resources

Philosophy
Philosophy

Religion
World Religions

Sciences
Science
Space/ Astronomy
Weather

History
Maps
Population
Travel

Earthcam
Features Page
Free Stuff
Gardening Guide
Grand Illusions
Greatest Films
Guinness World Records
Horoscopes
Late Night Jokes
Letterman Top Ten
MSN Gaming Zone
Online Quizzes
Oxymoron List
Poetry Daily
Ponder This
PublicRadioFan.com
Pun of the Day
Radio-Locator
Random Movie Review
Shakespearean Insulter
TerraServer Satellite Images
Text-To-Speech
Time Capsule
TruthOrFiction.com
Urban Legends & Myths
View Earth from Space
Visible Earth
What 's a Dollar Worth?
Yahoo! Games
Your Sky

Search the Web

Go

Google Search Tips

Tell a friend about Refdesk.com

Help Support Refdesk

refdesk.com

Make Refdesk Your Start-Up Page

BROWSER SETTINGS

- **AOL Web Browser - Version 8.0**
  When you click Internet on the AOL toolbar, the browser opens a predetermined world wide web page called the home page. When you install the AOL software, the home page is set to America Online's home page at http://www.aol.com/. You can change your home page at any time.

  To change the default browser home page
  1. On the Settings menu on the AOL toolbar, click Preferences.
  2. In the Organization section of the Preferences window, click Internet Properties (WWW).
  3. In the Home Page section of the General tab, type http://www.refdesk.com.
  4. Click the Apply button on the bottom, then click OK.

- **Microsoft Internet Explorer 5.0 and higher**
  1. Go to the "Tools" menu and choose "Internet Options."
  2. Click on the "General" tab.
  3. In the top Home page section type in http://www.refdesk.com.
  4. Click "Apply" button at the bottom.

5. Click "OK" button
6. **Quick Way to Set Home Page:** Left click on the icon immediately to the left of the link in the address bar while refdesk is open, hold the mouse key down and drag to the icon that resembles a house. Let go, and you'll be asked to confirm that you want refdesk to be your home page. Click Yes and refdesk is now your home page. WARNING: do not do this from this page or it will be your startup page. Do it from refdesk's come page at: http://www.refdesk.com

- **Netscape 4.01 and higher and Mozilla**
  1. Click "Edit" on menu bar
  2. Click "Preferences"
  3. Click the "Navigator" option
  4. In the "Home Page" text-entry box, enter http://www.refdesk.com.
  5. Click "OK."

  Ý
- **Microsoft Internet Explorer MAC 5.0**
  1. At the top left of your screen, click on the Apple icon to open the Apple menu.
  2. Go to the Control Panels and select Internet
  3. Click on the Web tab. In the middle of the window, in the Default Pages section, find Home Page and type in http://www.refdesk.com.
  4. Close the Internet window and click Save. Refdesk is now your default home page.

- **MAC X 10**
  1. Open Safari and in Safari menu select Preferences.
  2. Click the General icon.
  3. In the 'Home page' section type http://www.refdesk.com

- **Opera**
  1. Click "Navigation" on menu bar.
  2. Click on "Set Home Page"
  3. In the text-entry box, enter http://www.refdesk.com.
  4. Click "OK."

QUESTIONS/PROBLEMS

[Search Net] [Facts Subject Index] [Facts Encyclopedia] [Newspapers USA/World] [Report Broken Links]
[Fast Facts] [First Things First] [Quick Reference] [Site Map] [Top of Page] [HOME]

Webmaster: Bob Drudge
URL: http://www.refdesk.com/

[Contact Refdesk]